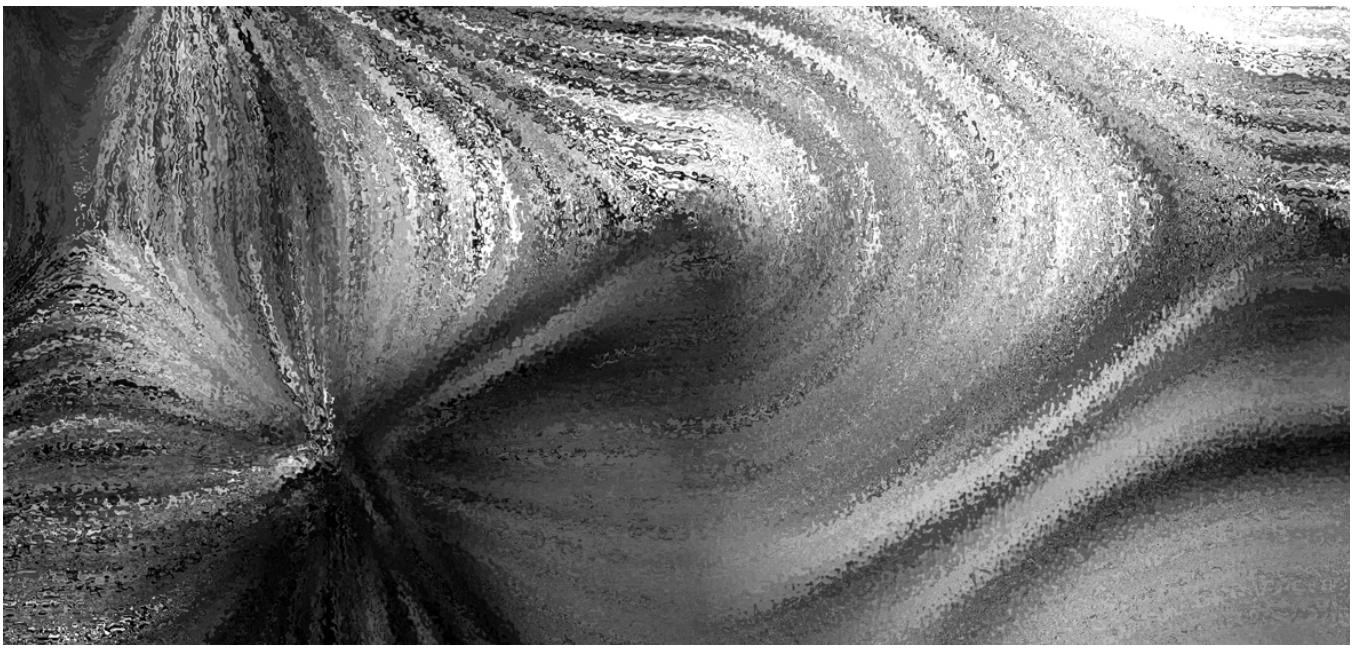
Exercise Physiology Assignments & Solutions



General Introduction

These questions are specifically designed to help provide you with a measure of your understanding of the subject.

A wide variety of styles of question are used; for example multiple choice, matching pairs, multiple completion, structured and essay; each designed to assess different levels of understanding, and to maintain interest. Some will also provide experience of the types of question found in most examinations.

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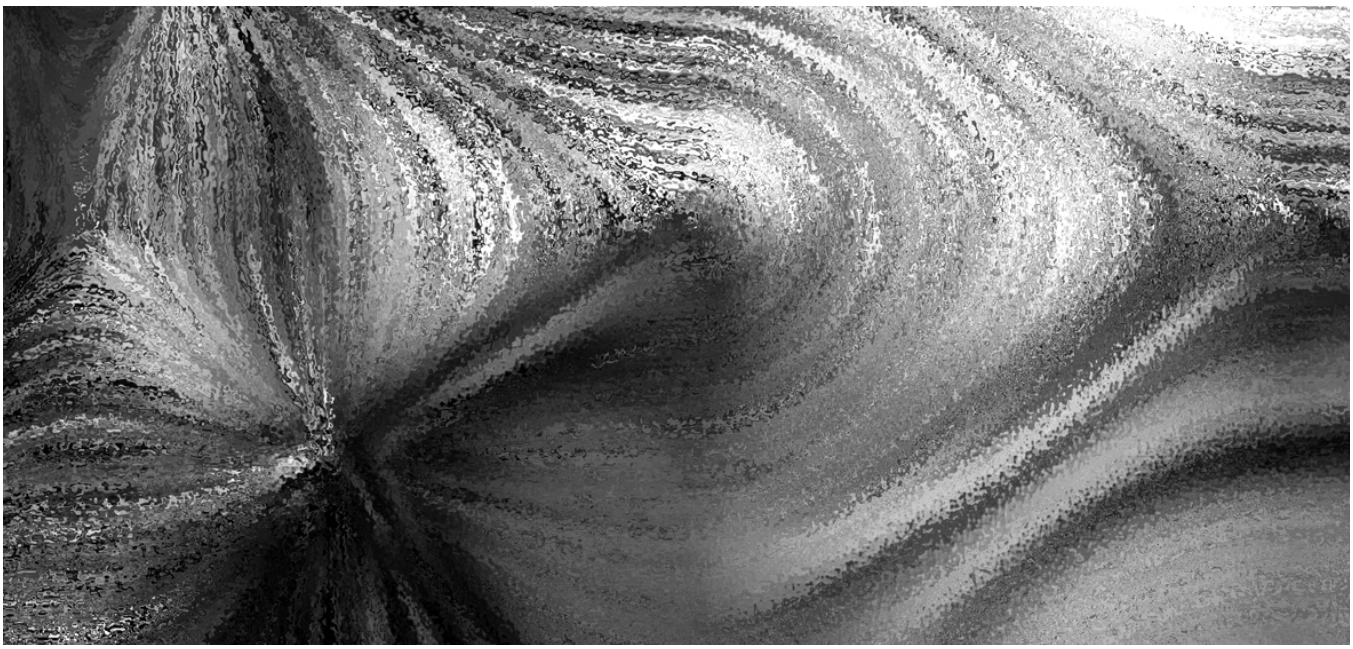
Questions



Muscles & Bones in Action Questions

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

1 **Which one of the following is the basic unit of the sliding filament mechanism?**

☐

A Sarcomere.

B Myofibril.

C Sarcoplasm.

D Muscle fibre.

---

2 **Which one of the statements below, referring to the sliding filament mechanism, is NOT correct?**

☐

A A single cross bridge may undergo many reconnections per second with the actin filament during a muscle contraction.

B In isometric contractions where the contracting muscle is prevented from shortening, the cross bridges do not operate.

C The coupling and uncoupling of the cross bridges continues if sufficient calcium ions are present.

D In the absence of free calcium ions, tropomyosin and troponin prevent the connection of cross bridges between myosin and actin.

---

3 **Which one of the following features is NOT characteristic of typical slow twitch (Type I) muscle fibres, when compared to fast twitch (Type II) muscle fibres?**

☐

A More myoglobin.

B More and larger mitochondria.

C Same amount of actin.

D More myosin.

E Better blood supply.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

4 **Considering the training of muscle fibres, which one of the following statements is NOT correct?**

☐

A Endurance training has no effect on the amount or activity of the enzymes in the mitochondria.

B Any increase in muscle size as a result of training is due more to the thickening (hypertrophy) of fibres already present, rather than to the increase in the number of fibres by the splitting of fibres.

C The proportion of different fibre types is not significantly altered by training.

D The oxidative potential of all fibres is improved by endurance training.

---

5 **With regard to a motor neurone stimulating a voluntary muscle, which of the following is NOT correct?**

☐

A A motor neurone releases the neurotransmitter substance acetylcholine.

B If the excitatory post synaptic potential (EPSP) exceeds a certain threshold it will initiate a motor unit contraction.

C Successive discharges from the motor neurone may summate to increase the EPSP.

D The neurotransmitter substance acetylcholine, once released continues to stimulate the muscle for a long period, eventually resulting in fatigue of the muscle.

---

6 **With regard to types of muscle contraction which of the following is NOT correct?**

☐

A Muscles shorten as they develop tension in isotonic contractions.

B Muscles do not shorten as they develop tension in isometric contractions.

C As the muscle contracts in an isokinetic contraction it exerts maximum tension over the full range of movement at all joint angles.

D Concentric contraction occurs at the front of the thigh when running down hill.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

7 **In which of the following types of muscle action does the muscle NOT shorten?**

A Isotonic.

B Isometric.

C Isokinetic.

8 **Which one of the following is the best explanation of the fact that when preparing to make a particular weighted shot in a tennis rally, experience enables the correct muscular effort to be produced?**

A Only fast twitch muscle fibres are activated.

B The speed of the tennis ball can be calculated.

C Gamma bias can preset the muscle spindles to the correct tension in anticipation.

D Only slow twitch muscle fibres are activated.

9 **Which of the following terms explains the role of the biceps muscle in flexing the arm?**

A Agonist.

B Antagonist.

C Fixator.

D Synergist.

10 **Which of the following muscles is mostly used when rising onto tiptoe, as in running and jumping?**

A 'Hamstrings'.

B Gluteus maximus.

C Gastrocnemius.

D Deltoid.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

11 **If a limb e.g. an arm, is raised laterally away from the body, which of the following terms describes the action?**

☐

A Adduction.

B Rotation.

C Flexion.

D Abduction.

12 **Which of the following is NOT concerned with the reduction of friction between moving parts at a synovial joint?**

☐

A Synovial fluid.

B Articular cartilage.

C Bursa.

D Ligament.

13 **The 'calf' muscle in fact consists of the gastrocnemius and which one of the following?**

☐

A Quadriceps.

B Tibialis anterior.

C Soleus.

D Sartorius.

14 **Which of the following are to be found in the 'thigh' muscles?**

☐

A Quadriceps.

B Deltoid.

C Trapezius

D Biceps brachii.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

15 **Listed below are four substances involved in muscle contraction.**

A Myosin.

B Troponin.

C Myosin ATPase.

D Actomyosin.

Which of these substances:

☐ **i** catalyses the breakdown of ATP?

☐ **ii** is produced by a physico-chemical coupling of actin and myosin?

☐ **iii** has a high affinity for calcium ions?

☐ **iv** has protein projections or cross bridges?

---

16 **Listed below are four types of muscle fibres.**

A Type I Slow Twitch.

B Type IIa Fast Twitch.

C Type IIb Fast Twitch.

D Type IIc Undifferentiated.

Which type of muscle fibre:

☐ **i** is also known as fast-oxidative-glycolytic or FOG?

☐ **ii** has the highest concentration of mitochondria?

☐ **iii** could be in the process of conversion as a result of training?

☐ **iv** has the richest supply of blood capillaries?

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of

to answer these questions.

---

17 **The following structures relate to the neuromuscular junction.**

A Postsynaptic membrane.

B Presynaptic vesicles.

C Synaptic cleft.

D Mitochondria.

Which of these:

☐ **i** Is stimulated by the neurotransmitter substance acetylcholine?

☐ **ii** Contain the neurotransmitter substance acetylcholine?

☐ **iii** Are the centres of ATP synthesis?

---

18 **Listed below are five types of muscle contraction.**

A Eccentric.

B Isometric.

C Isokinetic.

D Isotonic.

Which of these are involved in the following types of exercise?

☐ **i** Running down hill.

☐ **ii** Straining against an immovable resistance.

☐ **iii** Freestyle swimming armstroke.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

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19 **Listed below are four muscles or groups of muscles.**

A Latissimus dorsii.

B Trapezius.

C Pectoralis major.

D Sternocleido-mastoid.

Which of these is responsible for each of the following actions?

☐ **i** Pulls arms downwards and backwards.

☐ **ii** Pulls arm forwards and inwards.

☐ **iii** Draws head back and to sides, raises shoulder girdle.

---

20 **Listed below are four types of normal action.**

A Running down stairs.

B Climbing up stairs.

C Walking along the road.

D Pushing against an immovable object.

Which of these mainly involves:

☐ **i** eccentric action of the quadriceps?

☐ **ii** concentric action of the quadriceps and gluteus maximus?

☐ **iii** isotonic contractions of all leg muscles?

Matching Pairs Questions

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---

21 **Listed below are four muscles.**

A Deltoid.

B Biceps brachii.

C Gastrocnemius.

D Quadriceps.

Which of these muscles is located in which of the following 'regions' of the body.

☐ **i** 'Shoulder'.

☐ **ii** 'Calf'.

☐ **iii** 'Arm'.

---

22 **Listed below are four muscles.**

A Biceps brachii.

B Triceps brachii.

C Sartorius.

D Tibialis anterior.

Which of these muscles is used to:

☐ **i** cross the legs?

☐ **ii** flex the elbow joint?

☐ **iii** raise the foot up towards the shin?

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

23 ☐

In the sliding filament mechanism of muscle contraction:

i the cross bridges between the filaments move the actin filaments both ways.

ii the actin filaments are slid between the myosin filaments drawing the Z discs closer together.

iii the actin filaments are thinner than the myosin filaments.

---

24 ☐

When a sarcomere contracts:

i the H band disappears.

ii the Z discs move closer together.

iii the A band stays the same length.

---

25 ☐

With reference to muscle fibre types as predictors of performance:

i marathon runners always have more Slow Twitch fibres than sprinters.

ii sprinters always have more Fast Twitch fibres than marathon runners.

iii muscle fibre composition is not a good predictor of performance.

---

26 ☐

With respect to motor units:

i the fewer the muscle fibres in a motor unit the finer is the control of movement.

ii motor neurones supplying Slow Type I muscle fibres are of a different type to those supplying Fast Twitch Type II.

iii the fibre type of a motor unit cannot be altered by training.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

27 ☐

All the myofibrils of a single muscle fibre contract simultaneously when stimulated because:

i all the myofibrils are surrounded by the sarcoplasmic reticulum and supplied by the T tubules.

ii all the myofibrils are each supplied by one motor neurone.

iii all the myofibrils are connected by cross bridges.

---

28 ☐

An increase in the strength of the muscle response as a whole is achieved in the following ways:

i increasing the strength of the motor nerve impulse.

ii increasing the size of the motor nerve impulse.

iii increasing the number of motor units stimulated.

---

29 ☐

Golgi tendon organs are less sensitive than muscle spindles, because:

i tendons bear less force than muscles.

ii tendons are more elastic than muscles.

iii if they were more sensitive than muscle spindles they would inhibit normal use of the muscles.

---

30 ☐

Fine control of muscle contraction in sport is achieved:

i by indirect control via the muscle spindles.

ii in those muscles where there are only a few muscle fibres in each motor unit.

iii by the transmission of smaller nerve impulses.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

31 **In concentric muscle action:**

☐

i the muscle always shortens as it develops tension.

ii the action is always isotonic.

iii the bones to which the muscles are attached are never moved.

---

32 **In isometric muscle action:**

i the sliding filament mechanism does not operate.

☐

ii maximum tension is exerted over the full range of movement at all joint angles.

iii there is very little, if any, shortening of the muscle.

---

33 **Eccentric muscle action:**

i involves the operation of the sliding filament mechanism.

☐

ii involves the lengthening of the muscle by stretching.

iii is involved in plyometrics.

---

34 **In plyometrics:**

i the sliding filament mechanism is operating.

☐

ii elastic recoil is involved.

iii concentric muscle action is involved.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

35

☐

Fusiform muscles:

i produce rapid and wide ranging movements.

ii run longitudinally from tendon to tendon.

iii contract to their shortest possible length.

36

☐

Pennate muscles:

i have bundles of fibres radiating out from a single tendon running the length of the muscle.

ii are attached in positions that can result in powerful movements.

iii do not use the sliding filament mechanism.

37

☐

With reference to slow and fast twitch muscle fibres:

i some skeletal muscles consist of entirely one type or the other.

ii the proportion of each is determined genetically.

iii endurance training has an effect on both types.

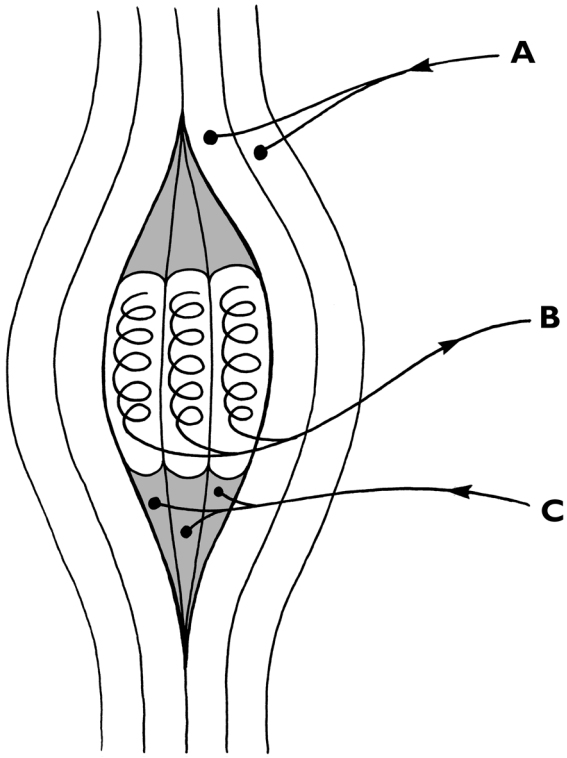
Section Total = *0/37*

0%

Structured Questions

38 **Study the simplified diagram of a muscle spindle apparatus and answer the questions that follow:**

Figure 1 *Simplified diagram of a muscle spindle apparatus.*



go to answer page

i What are the names of the neurones labelled A, B and C?

ii In what sequence would they transmit impulses in the fine control of muscle contraction?

iii When the spindle apparatus is stretched, which neurone conducts more impulses?

iv Which neurones have a smaller diameter and therefore conduct impulses more slowly?

Structured Questions

39 **Give short, concise answers to the following questions.**

i Why would depletion of the neurotransmitter acetylcholine reduce the stimulation of the muscles?

ii What two factors may reduce calcium ion release in the fatigued muscle?

iii When glycogen stores are depleted what are the effects on fat metabolism that contribute to fatigue?

iv What is the most important reason why an inadequate blood flow to the muscles causes fatigue?

vi What is meant by the term 'central fatigue'?

40 **Answer the following questions.**

i When the arm is flexed and extended, in what body plane is the movement occurring?

go to answer page

ii Describe the type of action that is occurring and in what plane, when an arm is raised sideways away from the body.

iii Give an example of rotation about a vertical axis in a transverse plane.

iv Of what value are these imaginary planes of movement in the body?

41 **Answer the following questions.**

i Name two muscles which attach to the humerus.

ii Name two antagonistic groups of muscles in the upper leg or 'thigh' region.

iii What movements result from contractions of the rectus abdominis muscles whilst standing?

iv Which muscles are mainly involved in the raising of the arms?

Essay Questions

Essay questions are designed not only to test facts, but also the ability to select and organise relevant material and to present it in a logical manner.

In addition to scientific content, marks are awarded for the understanding of the topic and therefore the relevance of the answer to the question, the range of material included, and the ability to communicate the information clearly in a well structured essay.

Thus there can be no single perfect answer to an essay style question. There will always be a subjective element in the marking that can never be completely standardised.

A well structured essay will include a brief introduction, with individual points developed in separate paragraphs. If the question requires some discussion and a statement of your opinion on an open-ended problem, then the essay could conclude with a brief summary paragraph. Any diagrams used should be relevant, and an integral part of the essay, they should not simply duplicate what has been written.

The sample essays provided are not 'model' answers as such, but simply examples to illustrate what might be achieved by a good candidate under examination conditions.

go to answer page

42 **Describe the characteristics of the main types of muscle fibre, and give an account of the effects of strength training, and stamina training on them.**

43 **Give an account of the ways in which muscles and bones interact to produce movement in the human body.**

go to answer page

Energy Relations in Action Questions

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

44 **Which one of the following statements relating to fat metabolism in the body is NOT correct?**

A Digestion of fat yields glycerol and free fatty acids (FFA's), which are then absorbed into the blood.

B Both glycerol and FFA's maybe used directly as respiratory substrates for respiring muscles during exercise.

C The breakdown and oxidation of fats share common pathways with those of carbohydrates, and when carbohydrates are depleted in long term exercise, fats can no longer be broken down efficiently.

D Fats represent a smaller energy store than carbohydrates.

E Fats can only be oxidised in the presence of oxygen, and therefore are only used as an energy source in aerobic exercise.

---

45 **During endurance exercise, aerobic respiration results in the complete oxidation of glucose into carbon dioxide and water for which one of the following reasons?**

A Lactic acid is not needed.

B Many more molecules of ATP are present in the blood.

C The Krebs cycle does not operate under aerobic conditions.

D With oxygen present the mitochondria function.

---

46 **The relative contribution of fat to the energy demands of the body is largely determined by which one of the following?**

A The supply of oxygen to the tissues.

B The amount of fat stored in adipose tissue.

C The amount of free fatty acids (FFA's) in the muscle fibres.

D The amount of glucose carried in the blood.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

47 **Which one of the following statements concerning lactic acid production during intense bouts of power activity is correct?**

A Lactic acid is a poisonous waste product which is excreted as fast as it is formed.

☐ **B** Lactic acid cannot be used as a respiratory substrate.

C Lactic acid is not produced by the activities of the phosphagen system which is largely used in short term power events.

D The presence of lactic acid will raise the pH of the body fluids, and therefore stimulate faster breathing.

---

48 **Which one of the following statements about the use of glucose during exercise is NOT correct?**

A Exercising muscles use blood glucose as a source of energy.

B The level of blood glucose is maintained by the liver breaking down glycogen.

☐ **C** Glucose can be produced from fats and proteins.

D Glucose solution drunk during exercise is not absorbed into the bloodstream.

---

49 **During intense periods of exertion of up to about 60 seconds duration, lactic acid accumulates in the muscles and the blood, for which one of the following reasons?**

☐ **A** The subject oxidises more fats under anaerobic conditions.

B The mitochondria are not functioning.

C There are not enough mitochondria in Slow Twitch muscle fibres.

D The capillaries to the muscles shut down.

E Lactic acid is not being removed from the working muscles.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

50 **Listed below are four hormones involved in the regulation of energy metabolism.**

A Adrenaline.

B Noradrenaline.

C Insulin.

D Glucagon.

☐ **i** Which one does not stimulate the conversion of glycogen to glucose?

☐ **ii** Which hormone inhibits the effects of the three others?

☐ **iii** The secretion of which hormone is stimulated by the intake of sugars?

---

51 **Listed below are three energy systems involved in anaerobic and aerobic respiration.**

A Lactic anaerobic.

B Alactic anaerobic.

C Aerobic.

In the performance of a top class runner over one mile which system is involved in each of the following ways?

☐ **i** As a source of energy in the first 3 seconds of effort.

☐ **ii** Is at its maximum rate of involvement at about half way.

☐ **iii** Is at its maximum rate of involvement in the finishing straight.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

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52 **The following terms relate to anaerobic respiration.**

A Onset of Blood Lactate Accumulation (OBLA).

B Excess Post Exercise Oxygen Consumption (EPOC).

C Oxygen Debt.

D Oxygen Deficit.

Which of the above terms is best described by each of the following definitions?

☐ **i** The amount of oxygen consumed during recovery from exercise, above that consumed in an equivalent period of rest.

☐ **ii** The point at which the rate of lactic acid production exceeds its rate of removal.

☐ **iii** The amount by which oxygen supply falls short of requirements in a period of exercise.

---

53 **Listed below are several activities.**

A Cross Channel swimming.

B Shot put.

C Marathon running.

D 3000 metres pursuit cycle racing.

Which of the above mainly involves each of the below?

☐ **i** Utilisation of the phosphagen system.

☐ **ii** Use of glycogen reserves.

☐ **iii** Generation of lactic acid.

☐ **iv** Aerobic oxidation of fat.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

54 **Listed below are the energy rich substances of the body.**

A Phosphocreatine (Creatine phosphate).

B Glycogen.

C Fat.

D ATP.

To which of the above is each of the following statements referring?

☐ **i** All energy transactions in the body are mediated through it.

☐ **ii** Represents the largest energy store in the body.

☐ **iii** Is depleted in around two hours of hard endurance work.

☐ **iv** Is only regenerated via ATP.

---

55 **Listed below are some changes in energy reserves in the body.**

A Increased glycogen stores in the liver and the muscles.

B Reduction in sub-cutaneous fat reserves.

C Increased Phosphocreatine stores.

To which of the above is each of the following statements referring?

☐ **i** Occurs as a result of a few days of low carbohydrate intake followed by a few days of high carbohydrate intake.

☐ **ii** Is best achieved by restricting calorie (joules) intake rather than by exercise alone.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

56 **In the alactic anaerobic phase of respiration in intense power activity:**

☐

i energy is derived from ATP and PC;

ii when the PC is depleted there is a loss of power;

iii the PC stores last for a shorter time than ATP.

---

57 **If the exercise is of the endurance type, where the oxygen delivery systems become capable of sustaining aerobic respiration then:**

i less energy is derived from PC and the stores of PC can be regenerated.

☐

ii more energy is derived from the aerobic oxidation of glycogen and glucose.

iii the availability of oxygen becomes the limiting factor in ATP regeneration.

---

58 **During the initial stages of carbohydrate breakdown in the cytoplasm of muscle fibres:**

i ATP is formed.

☐

ii glucose is broken down.

iii glycogen is converted into glucose.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

59 ☐

When the oxygen demand of the muscles exceeds the supply, as occurs in intense effort:

i lactic acid is produced.

ii the mitochondria, especially in the Slow Twitch muscle fibres, are not fully used.

iii ATP is not produced.

---

60 ☐

During continuous exercise fats are increasingly used to provide energy as:

i the duration of the exercise increases.

ii the number of Fast Twitch muscle fibres involved increases.

iii the intensity of the exercise increases.

---

61 ☐

Anticipation of physical activity, especially that which involves competition, results in the secretion of the hormone adrenaline. With respect to energy relations this aids performance, because:

i it increases the availability of glucose for respiration.

ii it increases the utilisation of fat as a respiratory substrate.

iii it increases the amount of ATP present in the cells.

Multiple Completion Questions

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C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

62 **In a game type sport, such as rugby:**

i heavy demands are made on the phosphagen system.

☐ **ii** no demands are made on the glycogen stores of the body.

iii an oxygen deficit is not developed.

---

63 **Despite the 100 m track event being considered a sprint event, competitors typically slow over the last 20 m or so, because:**

i the phosphagen system is depleted.

☐ **ii** glycogen stores are depleted.

iii lactic acid is accumulating.

---

64 **If you were undertaking a long training session lasting more than an hour, including rests, which of the below should be of top priority during the session:**

i to drink strong glucose solution every 10 minutes.

☐ **ii** to eat small snacks during the rest periods.

iii to drink isotonic energy solutions every 10-15 minutes.

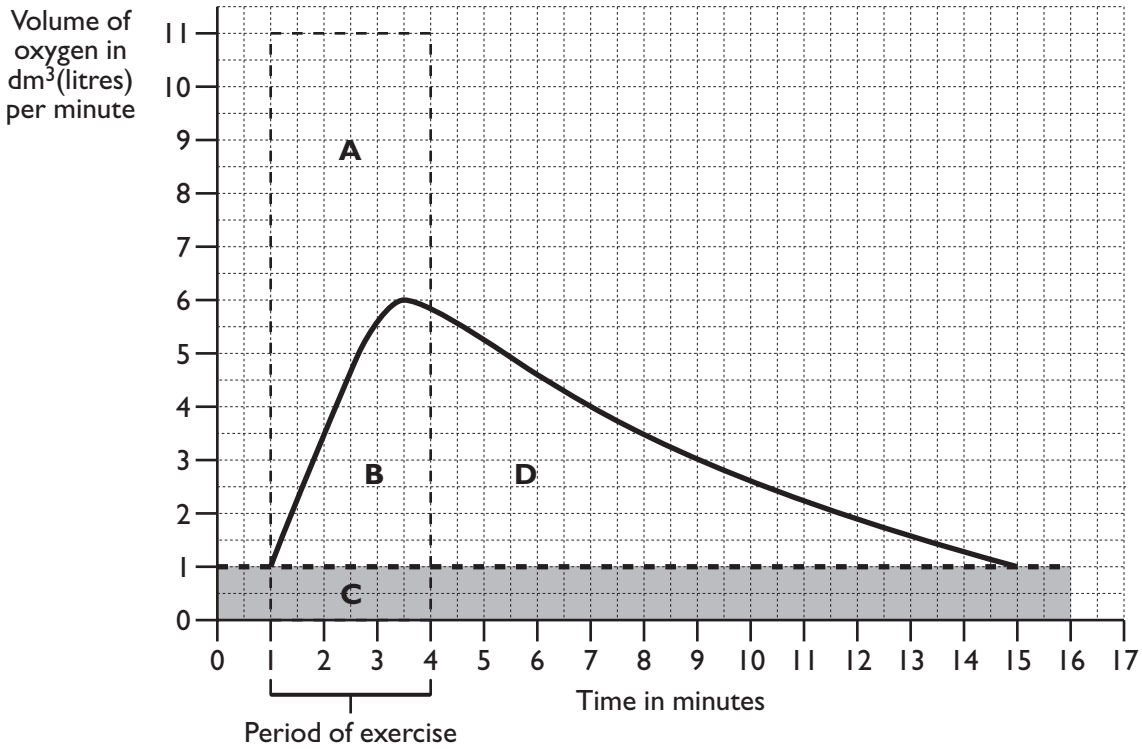
Section Total = *0/31*

0%

Structured Questions

65 **Study the graph provided and answer the questions that follow.**

Figure 2 *Graph showing the demand and use of oxygen by an athlete during a period of strenuous exercise*



go to answer page

i What does the horizontal dotted line on the graph represent?

ii What does the total area A + B + C represent?

iii Which of the areas represents the oxygen deficit?

iv Which of the areas represents the excess post–exercise oxygen consumption (EPOC)?

v What is the maximum rate of oxygen uptake by this athlete?

Structured Questions

66 **Give short, concise answers to the following questions.**

i What is an enzyme catalysed reaction?

ii What is a respiratory substrate?

iii What is a metabolic pathway?

iv What is the main metabolic pathway involved in energy relations?

v What is meant by 'anaerobic glycolysis'?

vi Why is anaerobic glycolysis a significant source of ATP in high intensity short term exercise, despite being only about 5% efficient?

go to answer page

Essay Question

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In addition to scientific content, marks are awarded for the understanding of the topic and therefore the relevance of the answer to the question, the range of material included, and the ability to communicate the information clearly in a well structured essay.

Thus there can be no single perfect answer to an essay style question. There will always be a subjective element in the marking that can never be completely standardised.

A well structured essay will include a brief introduction, with individual points developed in separate paragraphs. If the question requires some discussion and a statement of your opinion on an open-ended problem, then the essay could conclude with a brief summary paragraph. Any diagrams used should be relevant, and an integral part of the essay, they should not simply duplicate what has been written.

The sample essays provided are not 'model' answers as such, but simply examples to illustrate what might be achieved by a good candidate under examination conditions.

go to answer page

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67 **Distinguish between the immediate, short-term and long-term energy systems used during physical exercise. Illustrate your understanding of the application of the three systems by reference to appropriate sport performance.**

Circulation in Action Questions
Multiple Choice Questions

For each of the following questions, choose the ONE response which best answers the question.

---

68 **The following events occur during the cardiac cycle, but they are not listed in any particular order.**

i The ventricles contract (ventricular systole).

ii The atria contract (atrial systole).

iii The bicuspid and tricuspid valves are forced shut.

iv The pocket valves in the aorta and pulmonary artery are forced open.

v The bicuspid and tricuspid valves are forced open.

vi The pocket valves in the aorta and pulmonary artery are forced shut.

vii The ventricles relax (ventricular diastole).

Which one of the below represents the correct order of these events in the cardiac cycle?

A vii vi ii v iv i iii

B i v iii iv vii vi ii

C ii v i iii iv vii vi

D ii i v iii iv vii vi

---

69 **With regard to the increase in the heart rate with exercise. Which one of the following is NOT correct?**

A The heart rate is influenced by the activity of the autonomic nervous system.

B The increase in the heart rate is stimulated by the sympathetic nervous system.

C Increased secretion of adrenaline causes an increase in the heart rate.

D The heart rate is increased by information from sensory receptors in the working muscles and joints.

E The parasympathetic nervous system stimulates the increase in the heart rate.

Multiple Choice Questions

For each of the following questions, choose the ONE response which best answers the question.

70 **Which one of the statements below best explains the fact that endurance training results in the lowering of the resting heart rate?**

A The heart develops a bigger stroke volume.

B The heart has a larger cardiac output at rest.

C The maximum heart rate is lowered.

D Trained athletes have a greater tolerance of lactic acid.

E Trained subjects are less anxious.

71 **With regard to the blood pressure during exercise, which one of the following is NOT correct?**

A The blood pressure might rise as a result of an increase in cardiac output.

B The blood pressure rises more dramatically with isometric muscle contraction than with isotonic muscle contraction.

C The blood pressure increases because peripheral resistance is decreased by the closing of the capillary beds.

D Increased secretion of adrenaline increases the heart rate, and this contributes to any rise in blood pressure.

72 **Which ONE of the following alternatives best completes the statement that:**

'the heart would not be able to maintain a high cardiac output during exercise, unless:

A the heart rate was kept constant'.

B it was receiving an equal volume of blood from the veins'.

C the left ventricle pumped more blood than the right ventricle'.

D the left and right atria contract alternately'.

E the arteries carried most blood'.

Multiple Choice Questions

For each of the following questions, choose the ONE response which best answers the question.

73 **With regard to the velocity of the blood in the circulatory system, which one of the following is NOT correct?**

A The flow in the veins is much slower than in the arteries, as the blood is further from the heart.

B Blood flow is slow in the capillaries and allows for efficient exchanges with the tissues, especially the working muscles.

C During exercise the flow rate through the capillaries increases.

D The velocity of the blood in the pulmonary capillaries is faster than in the general circulation.

74 **With regard to the functioning of the lymphatic system during exercise which one of the following is correct?**

A It drains the excess tissue fluid, that is formed as a result of the increase in the blood pressure, away from the heart.

B The flow of lymph in the system is aided by the rhythmic massaging effect of the contracting muscles.

C The lymph vessel's pocket valves open and shut more rapidly to pump the lymph around the system.

D It carries less tissue fluid away from the tissues.

E The lymph nodes produce more lymph as exercise progresses.

Multiple Choice Questions

For each of the following questions, choose the ONE response which best answers the question.

---

75 **Fainting can occur as a result of a reduction in the blood supply to the brain, which one of the following is the best explanation of why this might occur directly after strenuous running?**

A Too much lactic acid has accumulated in the body.

B The body temperature has risen to dangerous levels as a result of the exertions.

C The viscosity of the blood has decreased due to greater tissue fluid production.

D More red blood cells have been produced under the stimulus of the effort.

E Venous return to the heart has decreased as a result of the cessation of the running action.

---

76 **The saphenous veins are superficial veins close to the surface of the leg, one of which runs up the length of each leg in the front. It is the longest vein in the body and is prone to becoming varicose, as in 'varicose veins'. Which one of the following is the best explanation as to why this vein should be so vulnerable to this condition**

A Repeated movements of the surrounding muscles weaken the wall of the vein.

B Raised blood pressure as a result of exercise expands the vein.

C The vein's pocket valves are weakened under the back pressure of blood due to gravity.

D Repeated heavy breathing in exercise increases the pressure inside the abdomen, which opposes the free flow of blood in the saphenous veins back into the main vein in the abdomen.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

77

Listed below are four types of blood vessel:

A Arteries.

B Capillaries.

C Veins.

D Arterioles.

Which vessels:

☐ **i** carry blood away from the heart?

☐ **ii** have most smooth muscle in their walls?

☐ **iii** have pocket valves along their length?

☐ **iv** have the smallest diameter?

☐ **v** carry blood back to the heart?

78

Four properties of cardiac muscle are:

A it can use lactic acid as a respiratory substrate;

B it has a long refractory period;

C of all tissues it has the highest extraction rate of oxygen from the blood;

D it cannot respire anaerobically to any extent.

Which of the above is an explanation of the fact that during exercise:

☐ **i** the coronary blood supply has to increase dramatically?

☐ **ii** it is not short of respiratory substrate?

☐ **iii** it does not develop an oxygen debt?

☐ **iv** it does not show merging or summation between successive contractions as is seen in muscle cramp?

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

79 **Features of the circulatory system which affect blood pressure are:**

A resting heart rate;

B stroke volume;

C peripheral resistance;

D viscosity of the blood.

Which of these:

☐ **i** is increased as a result of blood doping?

☐ **ii** is decreased by prolonged endurance training?

☐ **iii** is increased as part of the ageing process?

☐ **iv** is increased by prolonged endurance training?

☐ **v** is increased in static (isometric) exercises?

☐ **vi** is increased by the secretion of noradrenaline?

---

80 **The return of blood to the heart in the veins is assisted by:**

A massage by contracting skeletal muscles;

B breathing movements;

C constriction of the veins due to contraction of the smooth (involuntary) muscle in the walls;

D residual blood pressure;

E a reduction in the effect of gravity;

Which of the above is particularly reinforced:

☐ **i** in long distance running at an easy conversational pace?

☐ **ii** in anticipation of competition?

☐ **iii** whilst swimming?

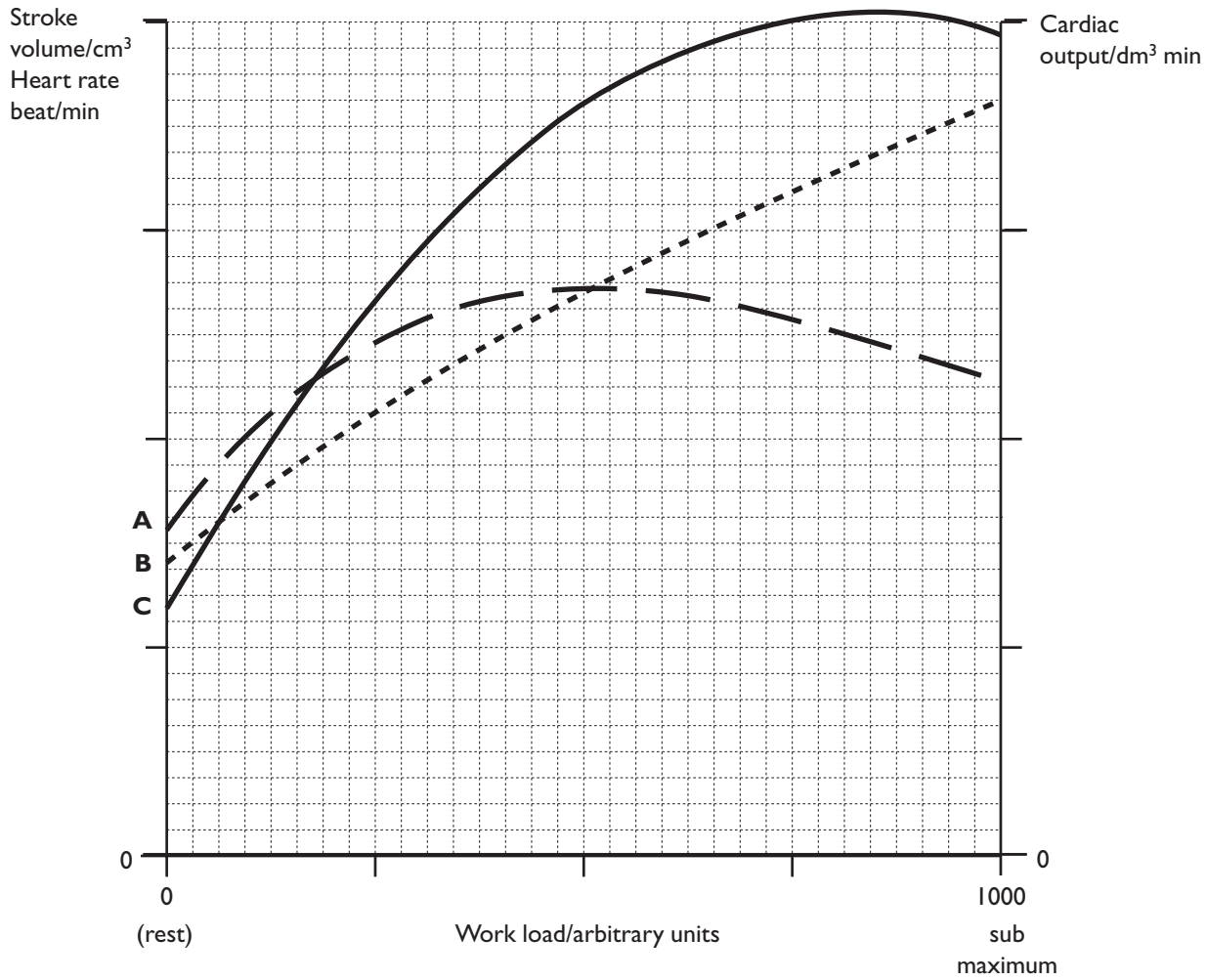
☐ **iv** during a standing recovery from a hard rally in a tennis match?

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

81 **Which of the curves shown in Figure 3 represents each of the following measures?**

Figure 3 *Changes in heart rate, stroke volume, and cardiac output with increasing work loads.*



- ☐ **i** Cardiac output.
- ☐ **ii** Heart rate.
- ☐ **iii** Stroke volume.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then select one of the following alternatives.

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

82 **In the cardiac cycle:**

i both atria contract together;

ii both ventricles contract together;

iii at one point all valves are shut.

---

83 **Cardiac muscle:**

i has interconnecting fibres which allow for the rapid spread of excitation;

ii has the highest concentration of mitochondria of all tissues;

iii can respire anaerobically if the demand for oxygen exceeds supply in short bursts of intense activity.

---

84 **With respect to changes of heart rate during exercise:**

i an increase in the activity of the sympathetic nerves stimulates an increase in the heart rate;

ii an increase in the activity of the parasympathetic nerves stimulates an increase in the heart rate;

iii a decrease in adrenaline contributes to an increase in heart rate.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then select one of the following alternatives.

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

85 **There is a fundamental difference between running and swimming as far as the functioning of the heart is concerned, because:**

☐

i the arm action of swimming affects the thorax and therefore the heart;

ii in swimming venous return is not opposed by gravity;

iii in running venous return is opposed by gravity.

---

86 **Adaptations that the heart shows to aerobic exercise over a period of time include:**

☐

i increased capillarisation of the cardiac muscle;

ii an increase in the size and number of mitochondria;

iii an enlargement of the ventricles.

---

87 **Blood pressure is increased during static (isometric) straining type exercises such as weight lifting because:**

☐

i venous return is interrupted;

ii the thorax and therefore the heart is compressed;

iii the capillary beds within the contracting muscles are compressed.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then select one of the following alternatives.

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

88 **With regard to the velocity of blood flow through the circulation:**

☐

i it speeds up as the cross-sectional area of the vessels becomes smaller;

ii it is slower in the veins than in the arteries;

iii it is entirely generated by the heart.

---

89 **Increasing the heart rate over a certain optimum limit is of no value in exercise, because:**

☐

i summation can occur leading to a tetanus or cramp of the heart muscle;

ii the heart develops an oxygen debt;

iii incomplete filling of the ventricles occurs.

---

90 **During exercise blood is shunted:**

☐

i away from the liver, gut and kidneys;

ii away from the skin in short intense periods of exercise;

iii to the working muscles.

---

91 **It is not advisable to exercise strenuously after donating blood to the transfusion service, because:**

☐

i there will be a drop in the blood glucose level;

ii sweating will be inhibited as less fluid is available for the sweat glands;

iii the smaller blood volume could lead to problems of blood pressure adjustment.

Structured Questions

92 **Study Table HC 1 and answer the following questions.**

Table 1 *The cardiac output and blood flow to various parts of the body whilst standing at rest, and during running (after Mitchell & Blomquist, 1971).*

cm^3/minute	Standing	Exercise
CARDIAC OUTPUT	6000	24 000
Blood flow to:		
Heart *(Coronary supply)*	250	1000
Brain	750	750
Active Skeletal Muscle	650	20 850
Inactive Skeletal Muscle	650	300
Skin	500	500
Kidney, Gut & Liver	3200	600

go to answer page

i How is the large increase in cardiac output brought about?

ii What must parallel the increase in cardiac output?

iii What is it about exercise that helps the phenomenon described in the answer to (ii), and therefore the cardiac output to be maintained?

iv How is it possible to deduce from the figures that at rest the cardiac muscle has a high extraction rate of oxygen from the blood?

v What additional reasons, other than anaerobic respiration by the active skeletal muscle, contribute to the increase in blood lactic acid (lactate) accumulation?

vi Why does the drastic reduction in blood supply to the kidney and gut not lead to them respiring anaerobically?

vii How is the shunting of blood to and from different regions achieved?

Structured Questions

93 **Give short, concise answers to the following questions.**

i In what ways do the sympathetic nerves stimulate an increase in the heart rate?

ii How can a decrease in parasympathetic (vagal) activity produce an increase in the heart rate?

iii Why should an increase in temperature, which inevitably occurs in exercise, contribute to an increase in heart rate?

iv Why is the increase in heart rate at the onset of exercise too rapid to be the result of the metabolic mechanisms concerned with cardiac acceleration?

go to answer page

Essay Question

Essay questions are designed not only to test facts, but also the ability to select and organise relevant materials and to present them in a logical manner.

In addition to scientific content, marks are awarded for the understanding of the topic and therefore the relevance of the answer to the question, the range of material included, and the ability to communicate the information clearly in a well structured essay.

Thus there can be no single perfect answer to an essay style question. There will always be a subjective element in the marking that can never be completely standardised.

A well structured essay will include a brief introduction, with individual points developed in separate paragraphs. If the question requires some discussion and a statement of your opinion on an open-ended problem, then the essay could conclude with a brief summary paragraph. Any diagrams used should be relevant, and an integral part of the essay, they should not simply duplicate what has been written.

The sample essays provided are not 'model' answers as such, but simply examples to illustrate what might be achieved by a good candidate under examination conditions.

go to answer page

94 **Compare and contrast the demands placed upon the heart and circulatory system during endurance events in running, cycling and freestyle swimming.**

Breathing, Gas Exchange and Transport Questions

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

95 **The following events occur during breathing in, but they are not listed in any particular order.**

i The volume of the thorax is increased.

ii The diaphragm contracts and flattens.

iii The ribs move up and out.

iv The external intercostal muscles contract.

v The air pressure within the lungs decreases below the external air pressure.

Which one of the following alternatives represents the correct sequence of events?

A ii iii iv i v

B ii i v iv iii

C iv ii iii v i

D iv iii ii i v

E iv iv ii iii

---

96 **Which one of the following statements about breathing movements during exercise is NOT correct?**

A Expiration occurs passively when the inspiratory control centre stops sending motor impulses.

B A degree of voluntary control can be exerted over the breathing movements.

C The rhythm of breathing is controlled by the rhythmic discharge of nerve impulses from the respiratory control centres in the brain.

D During exercise expiration is active.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

97 **Which one of the following is the main chemical stimulus for an increase in the breathing rate during exercise?**

A Carbon Dioxide (CO_2).

B Adrenaline.

C Noradrenaline.

D Acetylcholine.

E Hydrogen ion (H^+) concentration.

98 **Which one of the following is the main factor in increasing gaseous exchange by diffusion between the alveoli and the blood in the capillaries of the pulmonary circulation during exercise?**

A The contact time between the blood and the wall of an alveolus is increased.

B There is a decrease in the O_2 content of venous blood.

C The capillaries have very thin walls.

D More blood passes through the capillaries supplying the lungs.

E The ventilation rate is increased.

99 **Which one of the following is NOT a factor in increasing the gaseous exchange by diffusion between the working muscles and the blood in the capillaries supplying them during exercise?**

A Myoglobin has a higher affinity for oxygen than haemoglobin.

B An increase in temperature increases the release of oxygen from oxyhaemoglobin.

C More capillary beds open in the muscle.

D A decrease in pH increases the release of oxygen from oxyhaemoglobin.

E The low oxygen content in the muscles increases the diffusion gradient with the blood.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

100 **Which one of the following statements about the partial pressure (p) of gases in the alveoli, the blood, and the tissues during exercise is NOT correct?**

☐

A The pCO_2 in the alveolar air increases.

B The pO_2 in the active muscles can fall to almost zero.

C The pCO_2 in the venous blood is greater than that in the arterial blood.

D The pO_2 in venous blood is the same as that in the arterial blood.

E The pO_2 in alveolar air varies widely during the breathing cycle.

101 **What is the product of the tidal volume and the breathing rate per minute known as?**

☐

A VO_2 max.

B Maximum aerobic power.

C Large volume.

D Minute volume or minute ventilation.

E Vital capacity.

102 **Which one of the following is the most important stimulus of breathing?**

☐

A The amount of O_2carried in the blood as oxyhaemoglobin.

B The amount of O_2 in solution in the blood plasma.

C The amount of CO_2 in solution in the plasma.

D The amount of CO_2 combined with the haemoglobin as carbaminohaemoglobin.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

103 **Which one of the following is responsible for the movement of O_2 from the alveoli into the capillaries of the pulmonary circulation that surround the alveoli?**

☐

A The pumping action of the ribs and the diaphragm.

B The diffusion gradient of O_2 existing between the alveoli and the blood.

C The diffusion gradient of CO_2 existing between the alveoli and the blood.

D The speed of the blood passing through the pulmonary capillaries.

---

104 **Which one of the following is the best explanation of the fact that the efficiency of the lungs is rarely a limiting factor in aerobic exercise under normal conditions at sea level?**

☐

A At a certain intensity of exercise the ventilation rate increases proportionally more than the heart rate.

B Blood in the pulmonary veins is always virtually saturated with oxygen (carried as oxyhaemoglobin).

C The vital capacity cannot be significantly increased by training.

D The surface area of all the alveoli is not significantly increased by training.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

105 **Listed below are the various lung capacities and volumes:**

A Tidal volume.

B Dead air volume.

C Inspiratory reserve volume.

D Expiratory reserve volume.

E Vital capacity.

Which of the following definitions describes which of the above capacities and volumes?

☐ **i** The volume of air breathed in and out during quiet breathing.

☐ **ii** The extra volume of air that is taken in by breathing in as deeply as possible.

☐ **iii** The total amount of air that can be breathed during one maximum breath in and out.

☐ **iv** The air that occupies the space in the respiratory system where no gaseous exchange occurs.

☐ **v** The extra volume of air that can be released by breathing out as deeply as possible after quiet breathing.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

106 **Listed below are some features relating to gaseous exchange by diffusion between the air in the alveoli and the blood in the pulmonary capillaries.**

A The alveoli surface is covered with a thin layer of water and mucous.

B There is a contact time between the blood and the wall of the alveoli.

C The alveoli surfaces are ridged and corrugated by the pulmonary capillaries.

D Gradients of pO_2 and pCO_2 exist across the alveolar/capillary diffusion barrier.

Which of the above:

☐ **i** decreases during exercise?

☐ **ii** decreases the efficiency of the surface of the alveoli in gaseous exchange?

☐ **iii** is affected by the activities of the working muscles?

☐ **iv** increases the surface area for diffusion?

---

107 **Listed below are three points related to the transport of oxygen by the blood:**

A Oxygen combines reversibly with haemoglobin to form oxyhaemoglobin.

B Oxyhaemoglobin dissociates to release oxygen.

C Oxygen dissolves in the plasma.

Which of the above:

☐ **i** occurs in the capillaries of the pulmonary circulation?

☐ **ii** occurs in the working muscles?

☐ **iii** is increased by the decrease in pH which occurs during exercise?

☐ **iv** is increased by the increase in temperature which occurs during exercise?

☐ **v** increases if pure oxygen is breathed under high pressure as some sports people do?

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

108 **Listed below are four points relating to the transport of carbon dioxide in the blood.**

A CO_2 combines with plasma proteins to form carbamino compounds.

B CO_2 is carried as hydrogencarbonate ions in the plasma.

C CO_2 combines with haemoglobin to form carbaminohaemoglobin.

D CO_2 dissolves in solution in the plasma.

Which of the above:

☐ **i** is the main way in which CO_2 is carried in the blood?

☐ **ii** is increased by the enzyme carbonic anhydrase in the red blood corpuscles?

☐ **iii** is important in regulating the breathing rate during exercise?

---

109 **Listed below are three points relating to the breathing movements that ventilate the lungs.**

A The diaphragm rises during breathing out.

B The ribs descend during passive breathing out.

C The ribs rise during breathing in.

Which of the above:

☐ **i** Involves muscle contraction?

☐ **ii** Results in a decrease in pressure within the chest cavity?

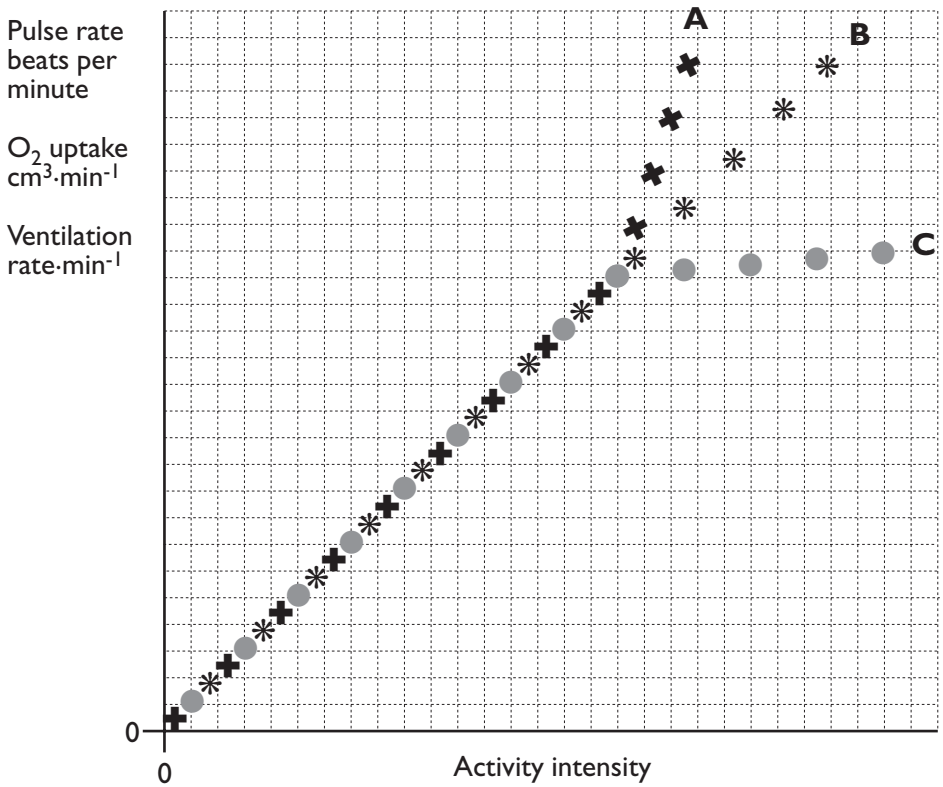
☐ **iii** Does not involve the inter-costal muscles?

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

110 **Which of the curves shown in Figure 4 represents each of the following measures?**

Figure 4 *Graph of pulse rate/ O_2 uptake/ ventilation rate against activity intensity.*



☐ **i** Pulse rate.

☐ **ii** Ventilation rate.

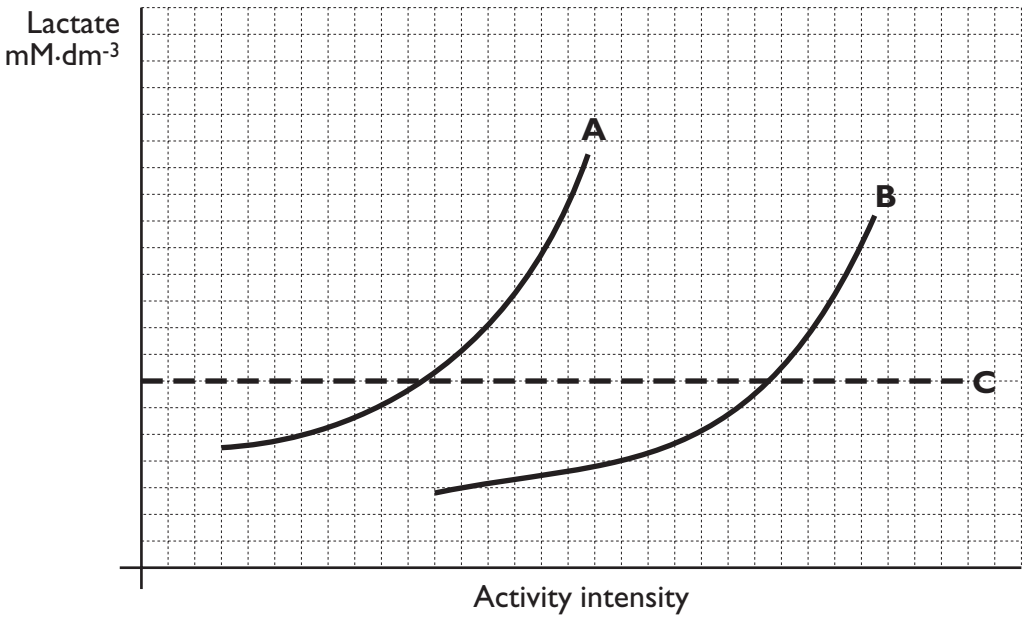
Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

111 **Which of the curves shown in Figure 5 represents each of the following measures?**

Figure 5 *Graph of blood lactate against activity intensity.*



☐ **i** The blood lactate levels of an untrained subject.

☐ **ii** The blood lactate levels of a trained subject.

☐ **iii** The blood lactate level considered to represent OBLA.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

112 **The maximum oxygen consumption or uptake is:**

i the greatest oxygen uptake an individual can achieve during exercise;

ii the greatest difference between the amount of oxygen which enters and leaves the lungs in cm^3;

iii a reliable indicator of performance in endurance events.

---

113 **Ventilation of the lungs is:**

i increased in proportion to the oxygen consumption;

ii a function of the rate and depth of breathing;

iii increased by an increase in pH.

---

114 **At the onset of blood lactate accumulation (OBLA):**

i there is a clear threshold of anaerobic respiration;

ii aerobic respiration begins to decrease;

iii ventilation increases more rapidly than does heart rate.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

115 **With regard to breathing air into and out of the lungs:**

☐

i the composition of air reaching the alveoli varies widely throughout the breathing cycle as the intensity of exercise increases;

ii on breathing out hard the lungs are completely emptied;

iii no significant gaseous exchange occurs in the anatomical dead space.

---

116 **The vital capacity:**

i represents the total amount of air that can be moved into and out of the lungs by one inhalation and one exhalation;

☐

ii shows a simple relationship to aerobic performance in endurance events;

iii is increased significantly by aerobic endurance training.

---

117 **Resistance to air flow in the air tubes:**

i is the major component of the total resistance of the lungs;

☐

ii during exercise is decreased by the secretion of adrenaline;

iii is increased by a spasm of the involuntary muscle in their walls.

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

118 ☐

With respect to the partial pressure of gases:

i it does not vary with altitude;

ii it equates to the percentage composition of gases in a mixture;

iii it also applies to gases in solution.

---

119 ☐

The difference in O_2 content between arterial and venous blood increases during exercise because:

i active muscles extract large volumes of oxygen from the blood;

ii active muscles produce large volumes of CO_2 in trained individuals;

iii active muscles respire anaerobically.

---

120 ☐

The diffusion capacity of the lungs:

i tends to be greatest in endurance athletes;

ii refers to the total amount of gas passing between the air and the blood in the capillaries of the pulmonary circulation;

iii is not much improved by training.

Section Total = *0/45*

0%

Structured Questions

121 **Give short, concise answers to the following questions.**

i Why does the composition of the alveolar air remain fairly constant at all times throughout the breathing cycle?

ii Why is this an advantage rather than a disadvantage?

iii Why could the film of moisture on the surface of the alveoli be considered as a disadvantage as far as the uptake of oxygen is concerned?

iv Why is the partial pressure of a gas a better measure of the amount of gas present than quoting its concentration as a percentage?

122 **The following results were obtained from a step test by a male subject of 80kg.**

go to answer page

	Respirometer measurements taken after:	Number of breaths per minute	Volume of each breath cm^3
a	30 mins rest	15	300
b	Stepping up and down 10 times on a stool 50cm high	20	500
c	Same exercise repeated 20 times	30	600

i What do the figures tell us about HOW the rate and depth of breathing increase in relation to each other as a result of exercise?

ii If the oxygen uptake was found to increase throughout the periods of exercise, what deductions could be made about the main type of respiration being used?

iii What would be a sign that OBLA (anaerobic threshold) had been reached ?

iv What would you expect to happen to the ventilation rate when exercise stopped ?

Essay Question

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The sample essays provided are not 'model' answers as such, but simply examples to illustrate what might be achieved by a good candidate under examination conditions.

go to answer page

123 **Explain why being 'out of breath' is a symptom rather than a cause of exhaustion.**

Exercise Fitness and Health Questions

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

124 **Which one of the following physiological characteristics does NOT directly play a part in accounting for the differences between males and females in long distance running events?**

☐

A Females typically have a smaller heart than males.

B Females generally have a smaller and lighter skeleton.

C Males typically have a greater haemoglobin concentration than females.

D Females typically have a proportionally smaller blood volume than males.

---

125 **Which one of the following statements referring to fitness in children up to puberty is NOT correct?**

A Children can be considered as small versions of adults with regard to training.

☐

B Girls may well be as large and strong as boys of their own age.

C Care must be taken not to overload bones whilst still growing.

D Flexibility is high and should be maintained into maturity.

---

126 **Which one of the following factors is the main cause of the differences in athletic ability between males and females after puberty?**

☐

A Males on average are taller.

B Females have a greater percentage of body fat.

C Males have greater lung capacities.

D Males produce higher levels of the male hormone testosterone.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

127 **Which one of the following changes contributes most to the loss of powers of endurance with age?**

A Loss of elasticity reduces lung volumes and gas exchange capacities.

☐ **B** Tendons and muscle sheaths tend to become 'stiffer'.

C Temperature control mechanisms become less efficient.

D Maximum heart rate, stroke volume, and cardiac output at a given work rate all decrease.

E There is a general rise in blood pressure.

---

128 **Which one of the following statements is NOT correct?**

A Regular, carefully graded aerobic exercise is associated with a decreased risk of cardio–vascular disease.

☐ **B** Exhaustive exercise depresses the activity of the immune system.

C Fitness results in a long life.

D Exercise protects against bone loss.

---

129 **Which one of the following statements is correct?**

A Females tend on average to live longer than males in western communities because they exercise more.

☐ **B** Excessive endurance work causes arthritis.

C Too much exercise will strain the heart.

D Exercise brings mental benefits as well as physical benefits.

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

130 **Listed below are four components of physical fitness.**

A Strength.

B Mobility / flexibility.

C Speed.

D Co-ordination.

Which of these components:

☐ **i** is health related?

☐ **ii** most involves the activity of the nervous system?

---

131 **The following are characteristic of the female anatomy.**

A They have a greater percentage body fat than males.

B They typically have a smaller heart than males.

C Their skeleton is generally smaller and lighter, with shorter limbs in relation to height.

D Their wider pelvis compared to males, reduces the direct line of thrust from the legs to the body.

Which of these characteristics:

☐ **i** could be an advantage in swimming events?

☐ **ii** would most reduce the mechanical efficiency of running?

☐ **iii** may be an advantage in events demanding balance and agility?

☐ **iv** would most limit their endurance capacity?

Matching Pairs Questions

For each of the following exercises, a list of possible answers, labelled **A, B, C, D** etc is provided. Several questions relating to these follow, and one of the alternative answers must be chosen for each question. Each of the alternative answers may be used once, more than once, or not at all to answer these questions.

---

132 **The following statements refer to the ageing process.**

A There is a decrease in contractility of the muscle fibres of the heart.

B There is progressive bone loss past the age of 40, increasing the amounts of calcium deposited in the walls of the arteries.

C A general reduction in the ability to synthesise proteins results in a loss of lean muscle mass.

D There is a loss of motor neurones.

Which of these best explains each of the following age related phenomena?

☐ **i** There is a 1% loss of strength per year.

☐ **ii** Blood pressure rises.

☐ **iii** Powers of endurance decrease.

Multiple Completion Questions

In the following questions, three alternative statements numbered i, ii and iii are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

133 ☐

Exercise has an effect on health in the following ways.

i Over-exertion whilst infected with a virus can lead to long term conditions such as 'glandular fever' or even heart disease.

ii Aerobic exercise of the correct type promotes longevity.

iii Carefully regulated aerobic exercise provides complete protection from the risk of a heart attack.

---

134 ☐

Endurance exercise has the following effects on the body.

i The sensitivity of the tissues to insulin is maintained.

ii The ratio of total blood cholesterol to high density lipoprotein (HDL) cholesterol is decreased.

iii The rate at which any blood clots present are destroyed is increased.

---

135 ☐

Exercise of all types has an effect on the musculo-skeletal system in the following ways.

i Bone loss in a process of demineralisation is prevented.

ii The tensile strength of tendons and ligaments is increased.

iii The synthesis of muscle tissue is decreased.

---

136 ☐

With regard to the definition of fitness and health:

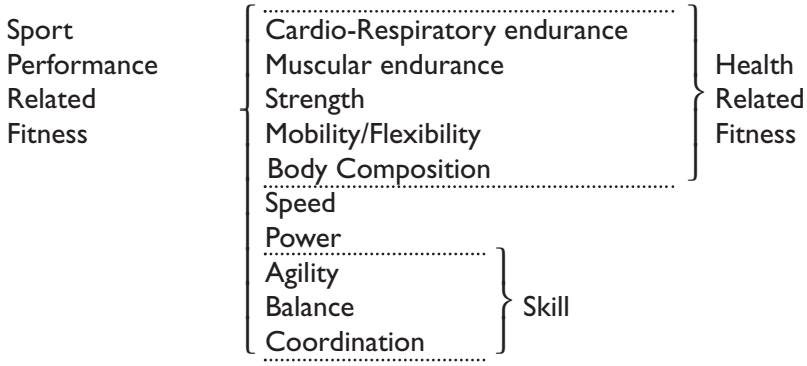
i both can be clearly defined and distinguished from each other;

ii fitness measures are neither valid nor reliable;

iii it is possible to be fit and unhealthy, and to be unfit and healthy.

Structured Question

137 **Study the table and answer the following questions.**



i Although only three Sport Performance Related Fitness Components (SPRFC) are bracketed as also being Health Related Fitness Components (HRFC), which of the others do you consider also have some relation to 'health'?

go to answer page

ii Three SPRFC's are bracketed as being involved in Skill, with regard to a skillful activity such as gymnastics, which others would also be most involved?

iii In common language athletes that outlast other competitors are often referred to as being 'strong'. Comment on this use of the word in this context.

iv Power is defined as being a combination of strength and speed. Give some examples of power events.

Essay Question

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go to answer page

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138 **Give an account of how a programme of carefully controlled, regular aerobic exercise would improve the health of a previously sedentary obese male.**

Training Principles Questions
Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

139 **Which one of the following statements referring to training effects is NOT correct?**

A They are very specific to the system being stressed.

B They are more effective if the system being trained is isolated from others.

☐ **C** For the body to increase its fitness it is necessary to expose it to progressive overload.

D Long term rest periods of several weeks enable the body to recuperate and maintain the new fitness levels.

E All training regimes can be designed to be sport or game specific.

---

140 **Which one of the statements below referring to measures of the heart rate in relation to training is correct?**

A Karvonen recommended continuous effort at an intensity of about 66% of the maximum heart rate.

☐ **B** The maximum heart rate can be estimated theoretically by subtracting one's age from 220.

C Heart rate increases in proportion to effort up to the maximum.

D The heart rate deflection point is an accurate measure of the 'lactate or anaerobic threshold'.

---

141 **Which one of the following statements referring to interval training is NOT correct?**

A Interval training can improve both anaerobic and aerobic powers.

☐ **B** The intensity of the efforts will determine the length of the recovery interval and the number of intervals possible in one session.

C An active recovery interval prevents the removal of the lactic acid accumulated during the work interval.

D A resting recovery interval prevents the regeneration of the ATP/PC system between efforts.

Multiple Choice Questions

For each of the following questions, choose the **ONE** response which best answers the question.

---

142 **Which one of the following statements referring to weight training is not correct?**

A It should only involve light weights under careful supervision in young immature athletes.

B Females lose strength more quickly than males, and therefore need to maintain some strength work throughout the year.

C Males build muscle more than females, as males generally have higher testosterone levels than females.

D It makes no demands on the slow twitch muscle fibres.

---

143 **Which one of the following statements referring to endurance training is correct?**

A It should only involve long slow distance work.

B There is no role for weight training.

C There is no role for speed work of any description.

D Adequate rest to allow for recovery between sessions is an essential part of any programme.

---

144 **Which one of the following statements referring to the effect of weight training on the heart is correct?**

A It has no effect on the heart.

B It has a greater effect on the thickness of the ventricle walls than it does on the stroke volume.

C It lowers the resting heart rate.

D It increases the resting heart rate.

Matching Pairs Questions

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---

145 **The following interval training regimes for runners are designed to train specific fitness 'compartments'.**

A 2 × (4 × 400m)

B 2 × (2 × 800m)

C 5 × (10 × 50m)

D 1 × (3 × 1000m)

Which of these trains the:

☐ **i** ATP/PC 'compartment'?

☐ **ii** lactic anaerobic/aerobic 'compartment'?

☐ **iii** aerobic 'compartment'?

---

146 **Listed below are four categories of strength.**

A Pure strength.

B Speed.

C Explosive power.

D Strength endurance.

☐ **Which of these categories is best trained by:**

☐ **i** plyometrics?

☐ **ii** 20 × 50% Repetition Maximum (RM)?

iii isometric contractions?

Matching Pairs Questions

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---

147 **Listed below are three types of stretching exercises:**

A Active stretching.

B Passive stretching.

C Ballistic or kinetic stretching.

Which of these types:

☐ **i** is performed with all the muscles relaxed?

☐ **ii** is performed by the action of the person's own muscles?

☐ **iii** utilises the momentum of body parts?

0%

Multiple Completion Questions

In the following questions, three alternative statements numbered **i, ii** and **iii** are given.

Consider carefully which is/are correct and then choose one of the following alternatives

A If **i, ii** and **iii** are correct.

B If **i** and **ii** only are correct.

C If **ii** and **iii** only are correct.

D If **i** only is correct.

E If **iii** only is correct.

---

148 **In circuit training:**

☐

i a circuit of exercises is performed at several work stations.

ii circuits can be designed to train various components of fitness.

iii consecutive stations are designed to concentrate the fatigue on the same muscle groups.

---

149 **If an athlete slightly increases their speed of running until maximum effort:**

☐

i up to a certain point the heart rate increases proportionally to speed.

ii past a certain point the heart rate does not increase in proportion to speed.

iii the heart rate deflection point can occur at higher exercise intensities than the 'lactate threshold'.

---

150 **Endurance training close to the 'lactate threshold':**

☐

i trains the aerobic systems to their limit without total discomfort.

ii is the same as training at the 'heart rate deflection point'.

iii does not train the anaerobic capacity in any way.

---

151 **Plyometric training:**

☐

i has a role in any event involving power production.

ii is particularly valuable in increasing flexibility.

iii is best undertaken on a daily basis.

Structured Question

152 **Answer the following questions relating to interval training.**

i Why, if the heart rate does not decrease to the correct level in the recovery interval, is the work interval considered too demanding?

ii What criticism could be levelled against training schedules following fairly rigid formulae such as the 180/120 regime?

iii What is meant by a 'set' in an interval training regime?

go to answer page

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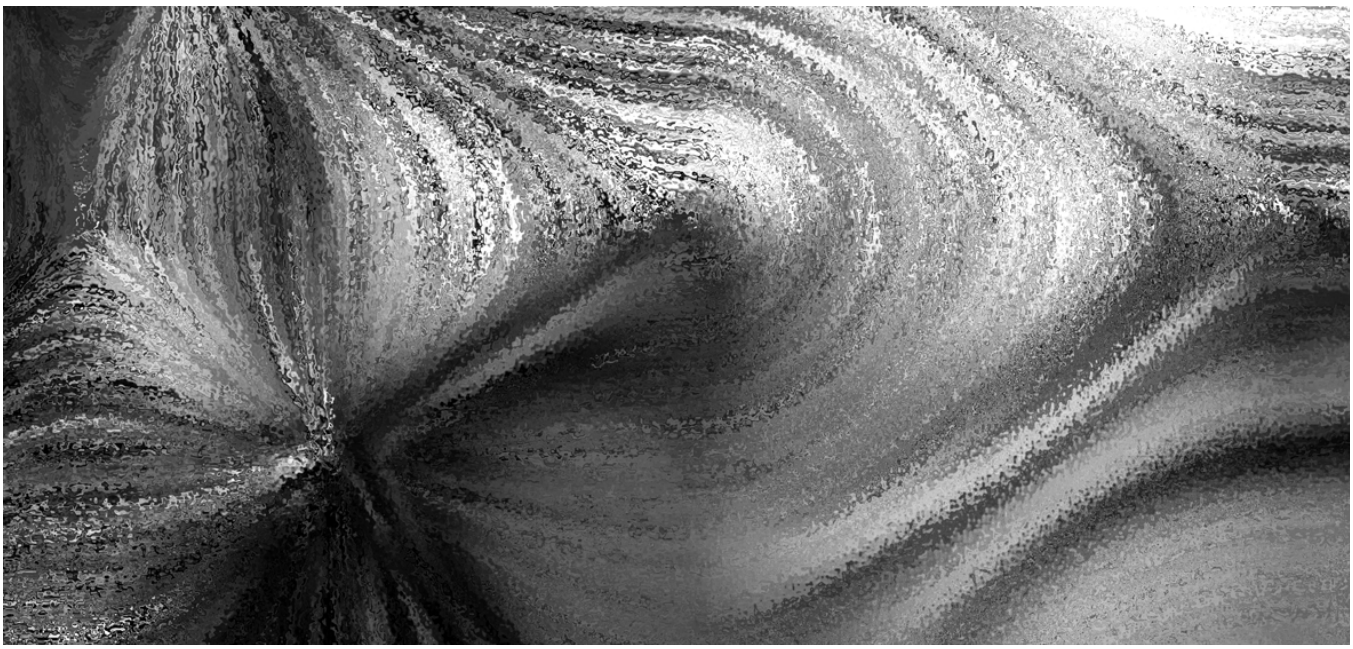
go to answer page

153 **How could a coach of a mixed group of athletes, including middle distance (800/1500 m) and longer distance (5000/10 000 m) runners, prepare them for the competitive season?**

Answers to Questions and Example Essays



Solutions Muscle & Bones in Action

Answers to Multiple Choice Questions

1 A	2 B	3 D	4 A	5 D
6 D	7 B	8 C	9 A	10 C
11 D	12 D	13 C	14 A	

Answers to Matching Pairs Questions

15	i C	ii D	iii B	iv A
16	i B	ii A	iii D	iv A
17	i A	ii B	iii D	
18	i A	ii B	iii C	
19	i A	ii C	iii B	
20	i A	ii B	iii C	
21	i A	ii C	iii B	
22	i C	ii A	iii D	

Answers to Multiple Completion Questions

23 C	24 A	25 E	26 A	27 D
28 E	29 E	30 B	31 D	32 E
33 A	34 A	35 A	36 B	37 C

Answers to Structured Questions

38

i **A** (alpha) motor neurone.

B sensory muscle spindle neurone.

C (gamma) motor neurone.

ii **C, B, A**

iii **B**

iv **C**

39

i Without acetylcholine diffusing across the synaptic cleft, no excitatory post synaptic potential (EPSP) can be generated in the post synaptic membrane, and the muscle would not be stimulated.

ii Transient T-tubule damage, and the inhibiting effect of hydrogen ions originating from accumulating lactic acid.

iii Fatty acids from the fat stores cannot be fully oxidised to release all their energy. Poisonous intermediates accumulate.

iv Sufficient oxygen to maintain aerobic respiration is not delivered to the working muscles.

v Fatigue caused by factors exerting an effect on the brain, for example, the depletion of blood glucose.

40

i Sagittal or paramedian.

ii Abduction in the frontal or coronal plane.

iii Rotating the head from side to side.

iv They help understanding of movement of segments of the body with respect to one another, so that consistent descriptions can be given of all the complex movements of the human body in a relatively simple form.

41

i Deltoid, and triceps brachii.

ii Quadriceps femoris and 'Hamstrings'.

iii Bending forwards (flexion in the sagittal or paramedian plane) and bending sideways (lateral flexion in the frontal or coronal plane).

iv Deltoid, trapezius and triceps brachii.

Example Essay to Question

42

Skeletal muscles contain two main types of fibre, namely the fast twitch and slow twitch muscle fibres.

Fast twitch fibres have a larger diameter and a faster contraction time, than the slow twitch fibres. They also have a higher anaerobic or glycolytic potential, which enables them to function under conditions of oxygen shortage, producing lactic acid as a result. They have high phosphocreatine (PC) and glycogen stores, but low myoglobin content, and few mitochondria.

Conversely slow twitch fibres, have a smaller diameter, and a slower contraction time than the fast twitch fibres. They also have a higher aerobic or oxidative potential, which means that they operate more effectively when the supply of oxygen is sufficient. They have relatively low PC and glycogen stores, but high myoglobin content and many more mitochondria.

In man the total number, and proportion of the different types of fibre within a particular muscle is fixed, and is not altered by training. This means that training must have its effect, by causing physiological changes in the muscle fibres.

Strength training and stamina training affects both fibre types in the same way, that is the strength induced changes occur in both types, as do the stamina induced changes.

Strength training increases their anaerobic or glycolytic potential, by increasing the enzymes of glycolysis that catalyse the break down of glycogen to pyruvic acid, and increasing their PC and glycogen stores. Their diameter is also increased, which presumably reflects the increases described above occurring in the cytoplasm, particularly in the fast twitch muscle fibres.

Stamina training increases the aerobic or oxidative potential of both fast and slow twitch muscle fibres. For example, stamina training results in an increase in the number, size and enzyme activity of mitochondria, myoglobin content and capillary density, so that the oxidative potential of both types of fibre is improved, and the genetic limit on the percentage of slow twitch fibres does not limit the maximum oxygen consumption that can be gained by training. In fact endurance training can raise the oxidative capacity of fast twitch fibres above that of the slow twitch fibres of an untrained subject.

An additional effect of both types of training on skeletal muscle, is an overall increase in the ability to tolerate higher levels of lactic acid.

The overall effect is that the muscles become stronger and capable of sustaining longer periods of exertion.

Example Essay to Question

43

Contraction of muscles attached to the bones by non-elastic tendons results in the movement of the bones via the joints. Muscles are only effective during contraction, and must be restretched when relaxed by the contraction of opposing or antagonistic muscles. For this reason, muscles are generally attached around joints in antagonistic pairs, so that the contraction of one extends the other. An example is seen with the biceps and triceps muscles, responsible for the flexion and extension respectively of the elbow joint.

The particular form of the muscle, along with the particular attachment of the muscle to the skeleton, determines the force and range of movement that can be produced. Fusiform muscles with long fibres running into flat strap-like tendons at each end allow maximum contraction, and are attached in positions that can result in rapid and wide ranging movements. An example is seen in the biceps which flexes the arm.

Pennate muscles with more, shorter fibres radiating out from a single tendon that extends the length of the muscle, are attached in positions that can result in more powerful movements. An example is seen in the rectus femoris muscle of the thigh that straightens the leg at the knee.

Movement of a bone about a joint as a result of muscle contraction can be described in terms of the action of levers. Bones are moved relative to each other via moveable joints known as synovial joints. Synovial joints are 'lubricated' with synovial fluid to prevent friction between moving bones, which is further reduced by smooth articular cartilages.

Most of the muscles of the body are attached between the joint (fulcrum or pivot) and the load, in an arrangement known as a 3rd class lever, this is mechanically inefficient in because much more effort or force has to be exerted to move the load. However, the advantage is that although muscle fibres can only contract up to about half their length, being attached in this way results in a wide range of movement at the end of the limb - which is particularly important in the movement of the arms and legs. In other words the human muscles and skeleton are arranged more for speed than strength.

Solutions Energy Relations in Action

Answers to Multiple Choice Questions

44 D	45 D	46 A	47 C	48 D
49 B				

Answers to Matching Pairs Questions

50	i C	ii C	iii C	
51	i B	ii C	iii A	
52	i B	ii A	iii D	
53	i B	ii C	iii D	iv A
54	i D	ii C	iii B	iv A
55	i A	ii B		

Answers to Multiple Completion Questions

56 B	57 A	58 A	59 B	60 D
61 B	62 D	63 D	64 E	

Answers to Structured Questions

65

i The resting oxygen requirement.

ii The total oxygen demand during the period of exercise.

iii **A**

iv **D**

v 6 dm^3 (litres) per minute.

66

i A reaction, the rate of which is speeded up by the presence of an enzyme, which is an organic catalyst produced by living cells.

ii An organic compound which is oxidised to release energy in the course of respiration.

iii A complex series of interconnected chemical reactions occurring within a living cell.

iv That of the breakdown of carbohydrates.

v The initial stages in the breakdown of carbohydrates during which energy is trapped into ATP, but no oxygen is involved.

vi It yields an immediate supply of ATP, before the oxygen dependent stages can come into operation.

Example Essay Answer

67

Although the three sources of energy used during physical exercise may be distinguished from each other, they share common pathways, and therefore their application to sport performance is similarly linked.

The energy system used as the most immediate supply of energy, is the phosphagen system of adenosine triphosphate (ATP) and phosphocreatine (PC). The energy is stored in each compound in the chemical bond linking a phosphate group to the rest of the molecule. The simple explanation is that if the chemical bond is broken and a phosphate group separated, then energy is released. This process is reversible, therefore energy may also be trapped in these substances.

$$ATP \underset{\text{Synthesis}}{\overset{\text{Breakdown}}{\rightleftharpoons}} ADP + P + \text{Energy} \qquad PC \underset{\text{Synthesis}}{\overset{\text{Breakdown}}{\rightleftharpoons}} C + P + \text{Energy}$$

These energy rich phosphate compounds are found in the muscle fibres, and act as an immediate energy supply for muscle contraction. ATP being directly involved in the molecular events of the sliding filament mechanism of muscle contraction. Oxygen is not involved in the direct exploitation of the energy stored in the phosphagen system, and lactic acid is not formed, so this can also be referred to as the alactic anaerobic system.

The energy system involved in the short term supply of energy is the lactic anaerobic system. This is used when the demand of the muscles for oxygen exceeds the supply, which occurs at the onset of most exercise and particularly during intense efforts lasting for up to a minute.In this system each glucose molecule is broken down in the absence of oxygen to yield energy sufficient for the regeneration of only 2 ATP molecules, and lactic acid accumulates as a by-product, which eventually inhibits physical exercise. This then is referred to as the lactic anaerobic system.

The energy system used in the long term supply of energy is the aerobic system. This is used when oxygen supplies match the demand of the muscles. In this system each glucose molecule is completely broken down in the presence of oxygen to yield energy sufficient for the regeneration of 38 ATP molecules.

With respect to the applications of these systems to sport performance, although all three are interlinked, greater or lesser demands are made on each depending on the sport activity.

The phosphagen system is exploited at the start of all exercise, but is particularly important in short, intense bursts of powerful activity. Therefore this system is almost the only one used in events such as the 100m track sprint, field events, weight lifting and games with short sharp bursts of activity such as football, rugby and hockey.

continued....

The lactic anaerobic system is utilised in intense efforts lasting for more than a few seconds, which in terms of sport performance, relates particularly to the 400 metres track sprint which is the classic lactic anaerobic effort. The energy released by this system is used to regenerate the phosphagen system, so both are used in this type of activity.

The aerobic system is always engaged to a greater or lesser extent, no matter what the sport, but the longer the steady-state activity, where oxygen uptake meets oxygen demand, the more will the aerobic system predominate. Therefore it is used in all endurance events of a steady continuous nature carried out below the 'anaerobic threshold'.This would apply more to non-competitive jogging and long distance walking or cycling, rather than to competitive events, in which the lactic anaerobic system will also be involved from time to time. Again all the energy released by the aerobic system is used to regenerate the phosphagen system, so both are used in this type of activity, and possibly all three if there is any anaerobic respiration.

Solutions Circulation in Action

Answers to Multiple Choice Questions

68 C	69 E	70 A	71 C	72 B
73 A	74 B	75 E	76 C	

Answers to Matching Pairs Questions

77	i A	ii A	iii C	
	iv B	v C		
78	i C	ii A	iii D	iv B
79	i D	ii A	iii C	
	iv B	v C	vi C	
80	i A	ii C	iii E	iv B
81	i C	ii B	iii A	

Answers to Multiple Completion Questions

82 A	83 B	84 D	85 A	86 A
87 A	88 D	89 E	90 A	91 E

Answers to Structured Questions

92

i By an increase in heart rate and stroke volume.

ii An equal increase in venous return.

iii Whilst standing at rest blood 'pools' in the legs under the force of gravity. During running the contracting muscles massage the veins, greatly increasing venous return to the heart.

iv The cardiac output increases during exercise by four times, and so does the coronary supply, and therefore there can be no 'spare capacity' of oxygen extraction at rest.

v Less blood is circulating to and returning from inactive muscles, kidneys, gut, and the liver which do not generate lactic acid, and more blood is circulating to and returning from active muscles which do generate lactic acid, therefore the lactic acid is less diluted and accumulates even more rapidly; also because the liver is largely responsible for the removal of lactic acid from the blood; a reduction in its blood supply will further contribute to the accumulation of blood lactic acid.

vi They have a relatively low extraction rate of oxygen from the blood, and the reduced supply is still sufficient to supply their needs. However, other aspects of their functioning will be impaired.

vii By vasoconstriction and vasodilation of arterioles, and opening and shutting of precapillary sphincters.

93

i By direct stimulation of the atria and ventricles and the 'pacemaker'; and by stimulating the release of adrenaline from the adrenal glands.

ii By reducing acetylcholine release, so that its inhibitory effect is removed.

iii Enzyme catalysed reactions are speeded up by increases in temperature, up to a certain optimum (typically 40°C). Therefore metabolism increases, therefore oxygen demand increases, and the heart rate increases to meet the demands being made on the circulation.

iv Metabolic mechanisms take longer than 60 seconds to increase the heart rate.

Example Essay Answer

94

The similarities between the demands made by these three activities are due to them all being aerobic endurance events.

The differences are due to the relative influence of gravity on the circulation in each activity.

These activities are all similar therefore, in the response of the heart and circulatory system to the demands of aerobic respiration by the tissues.

There is an increased cardiac output which is matched by an equivalent increase in venous return. The increased cardiac output is achieved by an increase in heart rate and stroke volume. This increased cardiac output is redistributed to the working muscles which in running and cycling are predominately in the legs, but in swimming are mainly in the arms, thorax and abdomen.

In cycling and swimming the legs do not have to bear the body weight, which reduces their work load and demand for oxygen. Also in freestyle swimming the leg actions are mainly balancing the arm actions, and this further lessens their relative demand for oxygen.

The increased venous return is aided in all three by muscle massage action, and by the increased breathing movements of the thorax, diaphragm and abdominal muscles.

It is the effect of gravity on the venous return of blood to the heart that causes the greatest contrast in the demands placed upon the heart and circulatory system in the three activities.

In running, gravity opposes venous return, especially from the legs, not withstanding the greater muscle massage by their working muscles, and there is a tendency for blood to accumulate or 'pool' in the legs. This restricts the filling of the ventricles, so that at high heart rates they may only partially refill during ventricular diastole. This in turn reduces cardiac output by decreasing the stroke volume.

The problem is reduced in cycling events as the legs do not bear the body weight, the posture of the body is off the vertical, and there is good rhythmic muscle massage of the leg veins.

In swimming events the problems are reduced even more by the horizontal position in the water. There is no gravitational force opposing venous return, no weight bearing and a good rhythmic movement of the legs. In the horizontal position, stroke volume is near its maximum at rest, and increases only slightly during exercise, so that any increase in cardiac output is achieved by increased heart rate. In addition there will be less redistribution of the blood than in running and cycling, as the muscle mass of the arms is much less than that of the legs.

Solutions Breathing, Gas Exchange, & Transport in Action

Answers to Multiple Choice Questions

95 D	96 A	97 E	98 B	99 A
100 D	101 D	101 C	103 B	104 B

Answers to Matching Pairs Questions

105	i A	ii C	iii E
	iv B	v D	
106	i B	ii A	iii D
	iv C		
107	i A	ii B	iii B
	iv B	v C	
108	i B	ii B	iii D
109	i C	ii C	iii A
110	i C	ii A	
111	i A	ii B	iii C

Answers to Multiple Completion Questions

112 B	113 B	114 E	115 E	116 D
117 A	118 E	119 D	120 A	

Answers to Structured Questions

121

i The 350 cm^3 of air of the tidal volume that reaches the alveoli mixes with the 150 cm^3 of air remaining in the dead space from the previous exhalation, so that 500 cm^3 of mixed air reaches the alveoli on each inspiration. Here it mixes with up to 2500 cm^3 of air that remains in the alveoli throughout quiet breathing.

ii It means that there are no wide fluctuations in diffusion gradients throughout the breathing cycle, so gaseous exchanges are virtually constant, irrespective of breathing in or out.

iii It increases the diffusion distance between the air in the alveoli and the blood, and oxygen diffuses faster as a gas, than in solution.

iv The percentage can remain the same whilst the amount is changing.

122

i Early in exercise the volume of each breath, that is the depth of breathing increases proportionally more than the rate: e.g. from (a) to (b) the rate of breathing increases 5/minute, that is an increase of:

$\frac{5}{15} \times 100 = 33\%$;

and the depth of breathing increases: $\frac{200 \times 100}{300} = 66\%$;

whereas later in exercise the rate of breathing increases proportionally more than the depth: eg.

from **(b)** to **(c)** the rate of breathing increases 10/min.,

an increase of: $\frac{10}{20} \times 100 = 50\%$;

and the depth of breathing increases: $\frac{125 \times 100}{500} = 25\%$

ii As the oxygen uptake continues to increase throughout the periods of exercise, respiration must be largely aerobic.

iii The ventilation increases more rapidly than the oxygen uptake at what is known as the 'ventilation breaking point'.

iv The ventilation rate would not return to the resting rate immediately on stopping exercise, but would continue at a higher rate until such time than the oxygen deficit had been made good, and the metabolic rate returned to its resting level.

Example Essay Answer

123

The discomfort felt in the chest when 'out of breath' may be as a result of the excessively violent movements being made by the ribs, diaphragm and abdominal muscles during breathing. Although this may generate some lactic acid, especially in the untrained subject, which can lead to feelings of discomfort, the muscles used in ventilation of the lungs only utilise about 10% of the total oxygen uptake.

At rest the circulation of the blood through the lungs is such that the contact time between blood and the wall of an alveolus is about 0.75 s. During exercise, although this is reduced to about 0.35 s, the rate of gaseous exchange is such that the blood can still come into equilibrium with the air in the alveoli. Even during maximum exercise the haemoglobin in the blood leaving the lungs is still virtually saturated with oxygen. So much so, that there is no advantage under normal atmospheric conditions, in breathing pure oxygen.

This would indicate that the uptake of oxygen by the lungs is not a limiting factor in exercise. The rate of breathing that can produce such discomfort as to lead to the cessation of exercise, is mainly determined by any increase in the acidity (decrease in pH) of the blood and the level of carbon dioxide dissolved in solution in the plasma (pCO_2). Both of these increase as a result of exercise. Carbon dioxide is produced as a result of respiration, and about 5% of the total carbon dioxide carried by the blood is in simple solution in the plasma. Up to another 5% may be combined with water in the plasma to form carbonic acid, which contributes to a decrease in the blood pH.

When the demand for oxygen by the working muscles exceeds the ability of the circulatory system to supply it, anaerobic respiration produces lactic acid which is the major cause of an increase in acidity of the plasma. When the blood lactic level reaches between 2-4 millimoles / litre of blood, the ventilation of the lungs increases more rapidly than the oxygen uptake. In other words one is breathing faster and deeper with no extra gain of oxygen. The point at which this break occurs between the ventilation of the lungs and the oxygen uptake is known either as the 'ventilation breaking point', the 'anaerobic threshold', or better, as the 'Onset of Blood Lactate Accumulation (OBLA)'.

Other causes of an increase in ventilation rate include the decrease in the pO_2 of the plasma, an increase in the blood levels of the hormones adrenaline and noradrenaline, an increase in body temperature, and sensory feedback from proprioceptors in the skeleton and muscles. The increased ventilation helps to get rid of excess carbon dioxide, but has little or no effect on the uptake of oxygen.

Being 'out of breath' is a symptom of exhaustion, caused particularly by the shortage of delivery to, and usage of oxygen by, the working muscles. It is not a cause of exhaustion itself.

Solutions Exercise, Fitness, & Health

Answers to Multiple Choice Questions

124 **B** 125 **A** 126 **D**

127 **D** 128 **C** 129 **D**

Answers to Matching Pairs Questions

130 **i A** **ii D**

131 **i A** **ii D** **iii C** **iv B**

132 **i C** **ii B** **iii A**

Answers to Multiple Completion Questions

133 **D** 134 **A** 135 **B** 136 **C**

Answer to Structured Question

137

i Body composition, as this includes the amount of body fat, which relates in many ways to 'health'. For example obesity is related to greater risks of high blood pressure, and therefore of heart attacks and strokes. Also, but less commonly, too little body fat has implications for health, for example disturbances of fat soluble vitamin levels, and disruption of menstruation in females.

ii Certainly mobility/flexibility to allow the range of movements involved; also strength, as many moves require great strength; not to mention speed and power which are also essential in many movements.

iii Strength means 'that force exerted by muscles in a single maximal contraction', as in weightlifting for example; whereas the characteristic referred to in the question is a combination of cardio-respiratory endurance and muscular endurance.

iv Perhaps the clearest examples are seen in the field events such as the shot, discus and javelin; but it is also obvious that many sports involve both strength and speed e.g. all top sprinters are also very strong and develop great power during the event.

Example Essay Answer

138

There is no clear definition of health; but it could be described as that state of the body (and of the mind) free of disease, that is compatible with an active and enjoyable life.

Some pre-existing conditions of ill health can be made worse by exercise, for example if heart disease is present then the risk of death is increased by exercise; and exhaustive exercise whilst infected with a virus can lead to long term (chronic) conditions such as 'glandular fever'. However, there is an accumulation of reliable scientific evidence that regular, carefully graded aerobic exercise of the correct type promotes what is generally understood as good health, both physical and mental.

With a previously sedentary obese male perhaps the main improvements in health would relate to a loss of body weight (although this could only be achieved in association with a properly balanced diet). This reduction in obesity would decrease the risk of heart disease via its effects on decreasing the ratio of total blood cholesterol to high density lipoprotein cholesterol, and on the lowering of blood pressure. The lowering of blood pressure would also reduce the risk of strokes.

Aerobic exercise also lowers the risk of heart disease by increasing the blood flow through the coronary arteries supplying the cardiac muscle of the heart wall, thus lowering the risk of a blood clot forming in these vessels (coronary thrombosis) and causing a heart attack. The risk of thrombosis is further reduced by an increase in the rate at which any clots that are present are destroyed, and by the prevention of the aggregation of blood platelets which are involved in the formation of blood clots.

In summary, vigorous aerobic exercise at least 3 times a week reduces the risk of a heart attack by at least 50%.

Other beneficial effects of aerobic exercise are that it maintains the sensitivity of the tissues to insulin, thus preventing or reducing the effects of Type II (mature onset non-insulin dependent) diabetes. It also protects against bone loss, preventing osteoporosis. Lung function is also improved, and by improving the quality of sleep and aiding relaxation, stress is relieved, which in turn has a beneficial effect on most aspects of health and particularly heart disease.

Solutions Training Principles Questions

Answers to Multiple Choice Questions

139 **D**	140 **B**	141 **C**
142 **D**	143 **D**	144 **B**

Answers to Matching Pairs Questions

145	i **C**	ii **B**	iii **D**
146	i **C**	ii **D**	iii **A**
147	i **B**	ii **A**	iii **C**

Answers to Multiple Completion Questions

148 **B**	149 **A**	150 **D**	151 **D**

Answer to Structured Question

152

i A raised heart rate indicates that not all the lactic acid or excess carbon dioxide has been buffered or removed from the circulation, and that the next work interval will be started from a state of incomplete recovery which will affect its quality.

ii Everybody is unique in their make up and will respond differently to the same training regime, even on a day to day basis.

iii A group of work and recovery intervals separated from another group by a recovery or rest interval longer than those within the group.

Example Essay Answer

153

Initially all the athletes would benefit from a period of aerobic conditioning provided by sessions of longer running. The length of this period would depend on the time available before the competitive season and the level of background fitness of the athletes. A simple way of judging the pace of the endurance runs is to run at an intensity just beyond that at which conversation stops. If heart monitors were available then it would be possible to apply the Karvonen principle and train at an intensity of about 66% of the heart rate reserve. Or alternatively the Conconi test could be undertaken to determine the 'lactate threshold' which is claimed to be the heart rate level at which endurance training is most effective.

Whichever method was chosen, unless all the athletes were of the same ability it would be difficult to keep the group together during these sessions, and some sort of regrouping procedure would need to be organised. After an extended period of aerobic conditioning, interval training could be introduced, whilst still retaining some steady running.

Judging the correct pace for the work interval, and the correct length of the recovery interval, would depend on the individual athlete. In general all the work intervals should be capable of being completed without slowing, and with the same recovery interval. If heart rate monitors are available then the heart rate levels can be used to determine the work and recovery intervals. Attempts to measure the pulse rate manually to determine the rates of work and periods of recovery are usually not very accurate.

Whilst both types of runner would benefit from interval sessions of all types, the 800/1500m runners looking for speed endurance would progress by increasing the intensity or speed of the work interval, whereas the 5000/ 10 000m runners, requiring more aerobic endurance, would progress the number and reduce the recovery interval.

As the competition phase is approached the number of work intervals would be reduced, and the passive recovery intervals extended until complete recovery was achieved - leading to 'fast repetitions'. Continued changes in this direction would lead to race simulations and time trials, just prior to competition. Throughout the training period allowance should be made for adequate recovery between sessions, and for a suitable periodisation depending on the time available.